Bycatch of the European purse-seine tuna fishery in the Atlantic Ocean for the period 2010-2016

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SUMMARY

This paper presents an update for the period 2010-2016 of the bycatch estimations for the European tuna purse seine fishery operating in the Atlantic Ocean. Bycatch data were collected by observers onboard. Observer coverage increased progressively from 15 trips in 2010, to 114 and 107 trips in 2015 and 2016 respectively. Bycatch data, as collected by the observers, were stratified by quarter and fishing mode (free school and floating object sets). The ratio of total to observed catches of the target species (skipjack, bigeye and yellowfin tunas) in each stratum was then used as raising factor. The average of the annual total bycatch estimated for the studied period was 9,515 t. Tunas (neritic tunas and small size tunas) represent the major part of the bycatch, followed by fin fish, sharks, billfishes, rays and turtles.

KEYWORDS: Bycatch, purse seining, Atlantic Ocean

Introduction

All fishing methods aim to extract wild species from the aquatic environment. When fishing, other accessory species, also known as "bycatch" are caught in addition to the target species. The bycatch varies according to various factors, like fishing techniques, or market factors (Kelleher, 2005). On the other hand, the dynamics of populations, such as seasonal migrations, high recruit's concentrations in certain areas or spawning in certain zones and times, can change the amount of bycatch seasonally and geographically (Lart *et al.*, 2002). Obtaining quantitative and qualitative information (composition by species) and its evolution over a period is fundamental for a better management of resources (Lart *et al.*, 2002), not only from the point of view of the management of commercial stocks but also from the point of view of ecosystem management.

Regarding the tropical tuna purse seine fishery, several papers and documents in the past have provided information on bycatches and discards (Peatman *et al*., 2017; Hall and Roman, 2013; Amandè *et al*., 2008), some of them referring specifically to the European purse seine fishery operating in the Atlantic Ocean (Amandè *et al*., 2010; Amandè *et al*., 2011).

The main objective of this paper is to present an update on the bycatch estimations for European tuna purse seine fishery operating in the Atlantic Ocean, with the aim of understanding better the impact of the fisheries on the environment. For this purpose, bycatch was defined as the discard of target species (skipjack, yellowfin and bigeye tuna) plus the catch of non-target species, whatever the fate is.

Method

Data

The data collected by independent observers during fishing operations are commonly used to complement other data, such as those from port sampling or skippers' logbooks. For some types of data, such as bycatch and discards, observer programs can be the most reliable, and sometimes the only source of information available. Observer programs are becoming an increasingly important tool to monitor tropical tuna fisheries. Under the ICCAT regulation, there is a recommendation of 5% coverage for large fishing vessels (ICCAT, 2010). Since 2003, Spain and France have been conducting a coordinated observer program as part of the Spanish and French National Programs for the Data Collection in the Fisheries sector established according to the European Regulations (Commission Regulation (EC) No. 665/2008). Since 2012, monitoring requirement increases to 100% for purse seiners during a two-month prohibition on FAD fishing in an area off western Africa (ICCAT Rec. 11-01; ICCAT Rec. 15-01). In addition, observer coverage increased significantly during recent years through private contracts between industry and scientific institutes. Data for the analyses has been collected under all these different monitoring programs.

Observer coverage increased progressively from 15 trips in 2010 to 114 and 107 trips in 2015 and 2016 respectively. Thus, the coverage of data varies significantly between the first years of the series, where only the DCF sampling existed, and the last ones where, through the different observer programs, the number of observed fishing operations is above 2,000 (**figure 1**). In terms of production, observed coverage is between 8-9% in the first years of the study period, and around 50-60% in the most recent years **(table 1).**

Analysis and raising

Bycatch was assumed to be linearly correlated with production (Amandè *et al*., 2010), understood as the total landings of target tuna species (skipjack, yellowfin and bigeye tuna). Thus, the total production of the EU purse seine fleet was used as the ratio estimator for the raising of the total bycatch in weight. Extrapolation was done yearly, and stratified by quarter and fishing type; sets on floating objects (FOB) and free school sets (FSC).

Results

The average of the annual total bycatch estimated for the studied period was 9,515 t, with a minimum of 6,734 t in 2011 and a maximum of 13,204 t in 2013 **(table 2; figure 2)**. **Figure 3** shows the same estimates by quarter. In relation to the fishing mode, most of the bycatch occurs in FOB sets, representing more than 80% of the total annual bycatch in the whole period, and reaching 95% in 2014 (**table 4**). Tunas (neritic tunas and discards of major tunas) represent the major part of the bycatch, followed by fin fish, sharks, billfishes, rays, and turtles.

Tunas

Tunas constitute the bulk of the bycatch both in FOB and FSC, between 67% - 89% and between 36% - 88% respectively (**table 4**). In terms of species composition, species of the genera *Auxis* and *Euthynnus* are the predominant, both in FOB and FSC. Regarding target species, skipjack is the main discarded tuna in FOB sets (around 20% of the total tuna bycatch). In the case of FSC, where the tuna bycatch is much lower, it is not so clear which is the predominant species. However, the importance of *Thunnus alalunga* is significant compared to that on FOB sets (**figure 4**).

Fin-fish

After tunas, "other fin fish" is the group that most contribute to the total bycatch, mainly due to FOB sets (**table 4**). In terms of species composition, the number of fin fish species present within the observed fishing operations exceeds 60 in FOB sets, and 40 FSC sets. However, there are a few predominant species in both cases (**figure 4**). *Acanthocybium solandri, Coryphaena hippurus, Elagatis bipinnulata, Canthidermis maculata and Caranx crysos* are the main caught species. However, this predominance is less evident in FSC sets, where *Mola mola* has a significant importance.

Shark

163 whale sharks (*Rhyncodon typus*) catch events were reported by observers during the whole studied period (**table 6**). These events where particularly reported in the Cape Lopez area. Whale sharks escaped from the net or were discarded alive almost always before the retrieval of the net. Subsequently shark group bycatch estimation did not include whale sharks.

In total terms, the estimated shark bycatch quantity is similar in FSC and FOB, and the annual average bycatch for the study period is around 245 t per year. However, the variability between years is higher in FSC **(table 2**). In terms of the species composition, *Carcharhinus falciformis* is the main species. In the case of the FOB sets, along with sharks of the family Sphyrnidae (mainly *Sphyrna lewini* and *Sphyrna zygaena*). In FSC sets, *Prionace glauca* becomes more important (**figure 4**).

Billfish

Billfish catches accounted for around 2% and 6% of the total bycatch in FOB and FSC sets respectively (**table 4**). In terms of species composition, *Makaira nigricans* is the predominant species in FOB sets, while *Istiophorus albicans* is the main species in FSC sets (**figure 4**).

Turtles

1,228 turtle catch events were reported by observers during the whole studied period, 925 in FOB sets and 303 in FSC sets (**table 7**). 99,1% were released alive. In terms of species composition, *Lepidochelys olivacea* was the main caught species followed by *Caretta caretta.* Regarding spatial distribution, most of the catches (68%) were observed in Cape Lopez.

Cetaceans

101 cetacean catch events were reported by observers during the whole studied period (**table 7**). All of them were discarded alive, and were discarded almost always before the retrieval of the net.

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Table 1. Observed coverage in terms of production

Production on observed trips							
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
FOB	3789	3160	4553	18201	32332	43059	35120
FSC	4531	5614	6127	12431	21957	25192	28827
Total	8320	8774	10680	30632	54289	68251	63947
Total EU production							
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
FOB	57666	56567	71497	78629	71721	69233	71581
FSC	52475	49493	48062	42562	37123	43160	53364
Total	110141	106060	119559	121191	108845	112393	124945
Observed production coverage							
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
FOB	7%	6%	6%	23%	45%	62%	49%
FSC	9%	11%	13%	29%	59%	58%	54%
Total	8%	8%	9%	25%	50%	61%	51%

Table 2. Estimated total bycatch (tones) by species group and fishing mode for the period 2010-2016.

	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
FOB							
Billfishes	136	99	184	126	133	135	147
Other bony fishes	699	955	1,929	1,192	1,196	1,767	2,256
Rays	10	7	40	100	19	11	35
Sharks	131	190	125	290	353	360	402
Tunas nei	7,899	4,156	9,842	5,960	6,188	5,226	5,741
Turtles	27	7	21	22	20	10	28
Total FOB	**8,902**	**5,414**	**12,142**	**7,689**	**7,910**	**7,510**	**8,609**
FSC							
Billfishes	106	73	87	62	31	37	41
Other bony fishes	95	23	310	12	7	16	18
Rays	31	11	11	27	6	11	32
Sharks	148	42	3	229	146	462	664
Tunas nei	1,473	1,164	617	191	246	1,278	639
Turtles	14	7	33	7	6	6	8
Total FSC	**1,868**	**1,320**	**1,062**	**528**	**442**	**1,810**	**1,402**
TOTAL	**10,770**	**6,734**	**13,204**	**8,216**	**8,352**	**9,319**	**10,011**

Table3. Bycatch tones per 1000 t of production (BET + YFT + SKJ landed) by species group and fishing mode for the period 2010-2016.

		2010	2011	2012	2013	2014	2015	2016
	FOB							
Billfishes		2.82	1.93	2.53	1.62	1.89	1.95	2.03
Other bony fishes		13.26	15.08	27.06	18.55	16.85	26.08	29.77
Rays		0.12	0.15	0.94	0.85	0.28	0.16	0.47
Sharks		1.97	2.78	1.18	4.48	5.14	5.09	5.69
Tunas nei		106.67	53.03	128.32	72.81	84.22	75.84	83.53
Turtles		0.46	0.10	0.42	0.23	0.25	0.14	0.37
	FSC							
Billfishes		2.03	1.56	2.23	1.23	0.82	0.83	0.78
Other bony fishes		1.79	0.52	2.96	0.30	0.16	0.33	0.37
Rays		0.58	0.22	0.27	0.56	0.14	0.26	0.56
Sharks		2.81	1.06	0.07	5.55	3.28	10.73	11.43
Tunas nei		27.48	34.12	15.92	3.87	6.30	30.48	11.30
Turtles		0.27	0.18	0.37	0.14	0.15	0.11	0.14

Table4. Estimated bycatch percentage by fishing mode for the period 2010-2016.

		2010	2011	2012	2013	2014	2015	2016
FOB		**83%**	**80%**	**92%**	**94%**	**95%**	**81%**	**86%**
	Billfishes	2%	2%	2%	2%	2%	2%	2%
	Fin fish	8%	18%	16%	15%	15%	24%	26%
	Rays	0%	0%	0%	1%	0%	0%	0%
	Sharks	1%	4%	1%	4%	4%	5%	5%
	Tunas	89%	77%	81%	78%	78%	70%	67%
	Turtles	0%	0%	0%	0%	0%	0%	0%
FSC		**17%**	**20%**	**8%**	**6%**	**5%**	**19%**	**14%**
	Billfishes	6%	6%	8%	12%	7%	2%	3%
	Fin fish	5%	2%	29%	2%	2%	1%	1%
	Rays	2%	1%	1%	5%	1%	1%	2%
	Sharks	8%	3%	0%	43%	33%	26%	47%
	Tunas	79%	88%	58%	36%	56%	71%	46%
	Turtles	1%	1%	3%	1%	1%	0%	1%

Table 5. Number of events with cetaceans observed during the period 2010-2016

		2010	2011	2012	2013	2014	2015	2016
FOB				**5**		**10**	**5**	**5**
	Delphinidae			1				
	Globicephala macrorhynchus					4		
	Globicephala melas			4				
	Mammalia					1	4	4
	Megaptera novaeangliae						1	
	Mysticeti					5		1
FSC		**17**	**1**	**3**	**2**	**40**	**18**	**96**
	Balaenoptera edeni	1					2	5
	Balaenoptera physalus	12			1	1		
	Globicephala macrorhynchus			3				
	Globicephala melas				1			
	Mammalia	1				23	4	42
	Megaptera novaeangliae	3				1		3
	Mysticeti		1			12	12	46
	Physeter macrocephalus					3		

Table 6. Number of whale shark catches observed by ET area during the period 2010-2016

AREA	2010	2011	2012	2013	2014	2015	2016	TOTAL
Cap Lopez	5		2	5	33	20	62	127
Equator NE					20		1	21
Nord Piccolo			1		5	1	1	8
Piccolo			1					1
Senegal					1	1		2
Sud Equator	2			2				4
TOTAL	7	0	4	7	59	22	64	163

Table7. Number of turtle catches observed and their fate, by ET area during the period 2010-2016

		Cape Lopez	Equator NE	Nord Piccolo	Piccolo	Senegal	Sud Equator	Total
FOB		**687**	**67**	**33**	**11**	**91**	**36**	**925**
Thrown alive into the sea								
	Caretta caretta	55	7	10	1	63	3	139
	Chelonia mydas	36	3			1		40
	Dermochelys coriacea	5	1	8	1	1	4	20
	Eretmochelys imbricata	5	2			2		9
	Lepidochelys kempii	20	2		1		1	24
	Lepidochelys olivacea	520	36	11	6	19	26	618
	Non identified turtle	44	13	4	2	3	1	67
Thrown dead into the sea								
	Caretta caretta		1					1
	Eretmochelys imbricata		1					1
	Lepidochelys olivacea	1	1			2	1	5
	Non identified turtle	1						1
FSC		**153**	**45**	**50**	**11**	**20**	**24**	**303**
Thrown alive into the sea								
	Caretta caretta	7	5	15		16	1	44
	Chelonia mydas	8	4				2	14
	Dermochelys coriacea	2	1	22	1		9	35
	Eretmochelys imbricata	3	1	1	1			6
	Lepidochelys kempii	11	3	1				15
	Lepidochelys olivacea	112	24	7	8	3	12	166
	Non identified turtle	10	6	2	1	1		18
Thrown dead into the sea								
	Dermochelys coriacea			1				1
	Lepidochelys kempii		1					1
	Lepidochelys olivacea			1				1

Figure 1. Number of sets observed by fishing mode (FOB: sets on floating objects; FSC: sets on free schools)

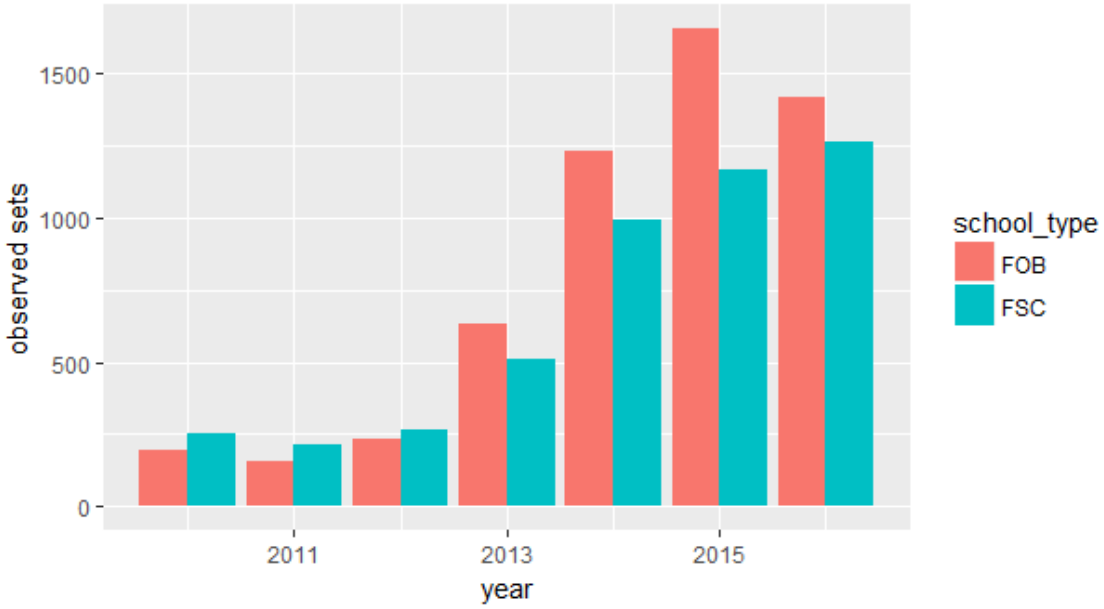


Figure 2. Total estimated bycatch (tons) by species group for the period 2010-2016.

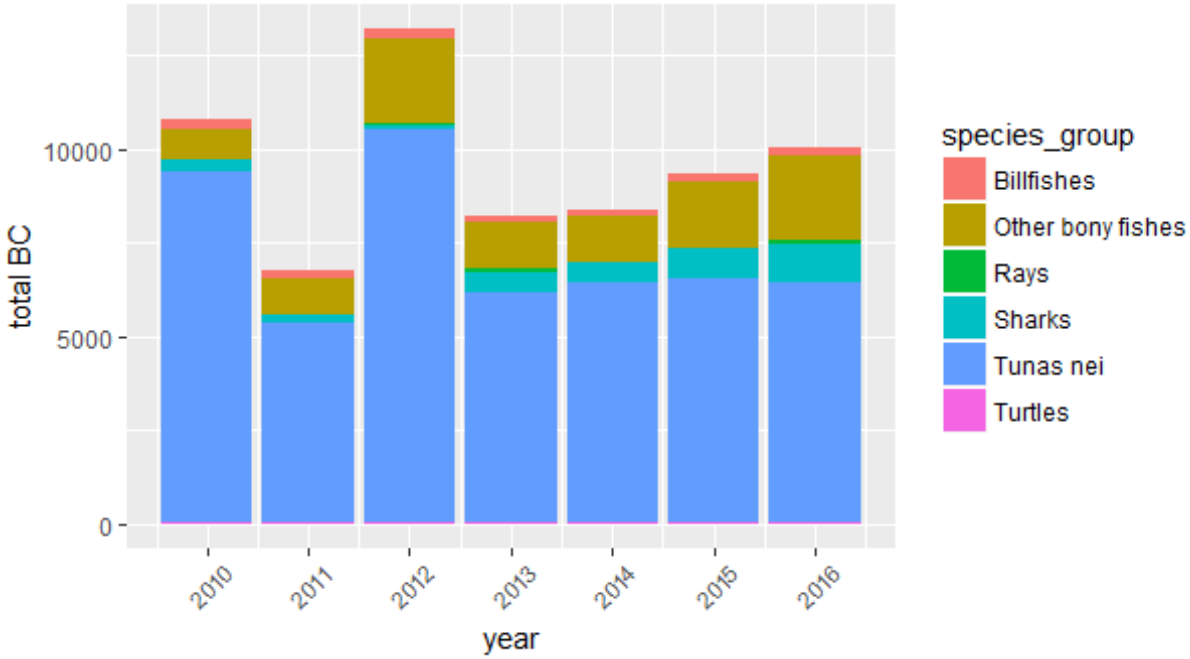


Figure 3. Total estimated bycatch by species group and quarter, for the period 2010-2016.

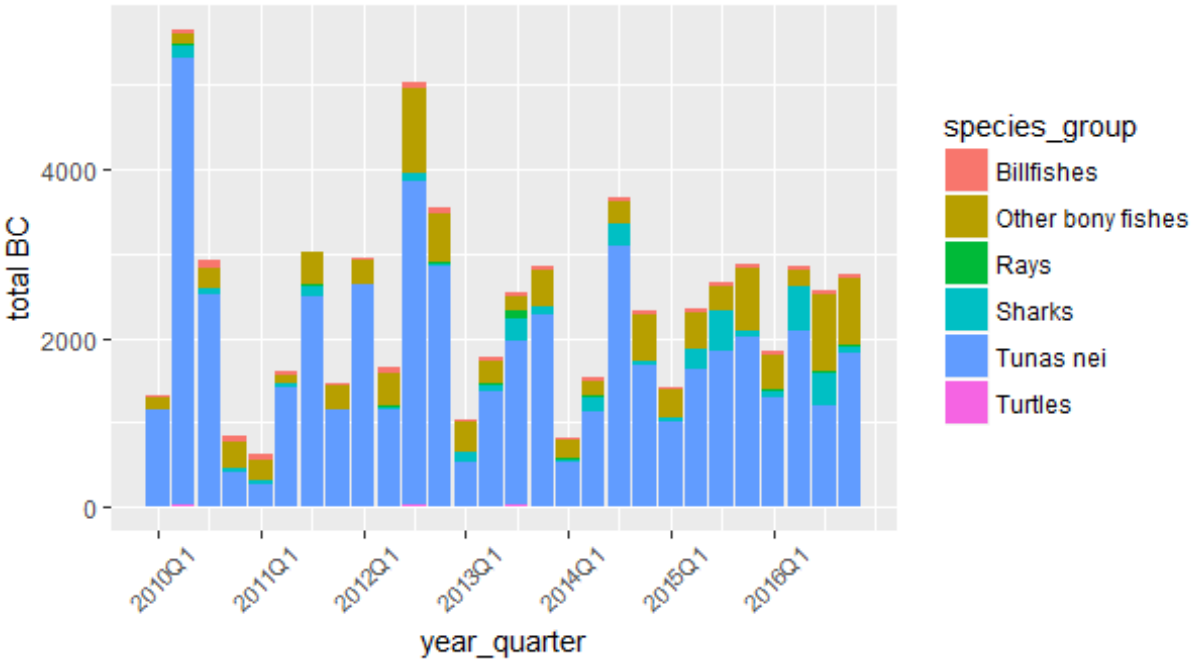
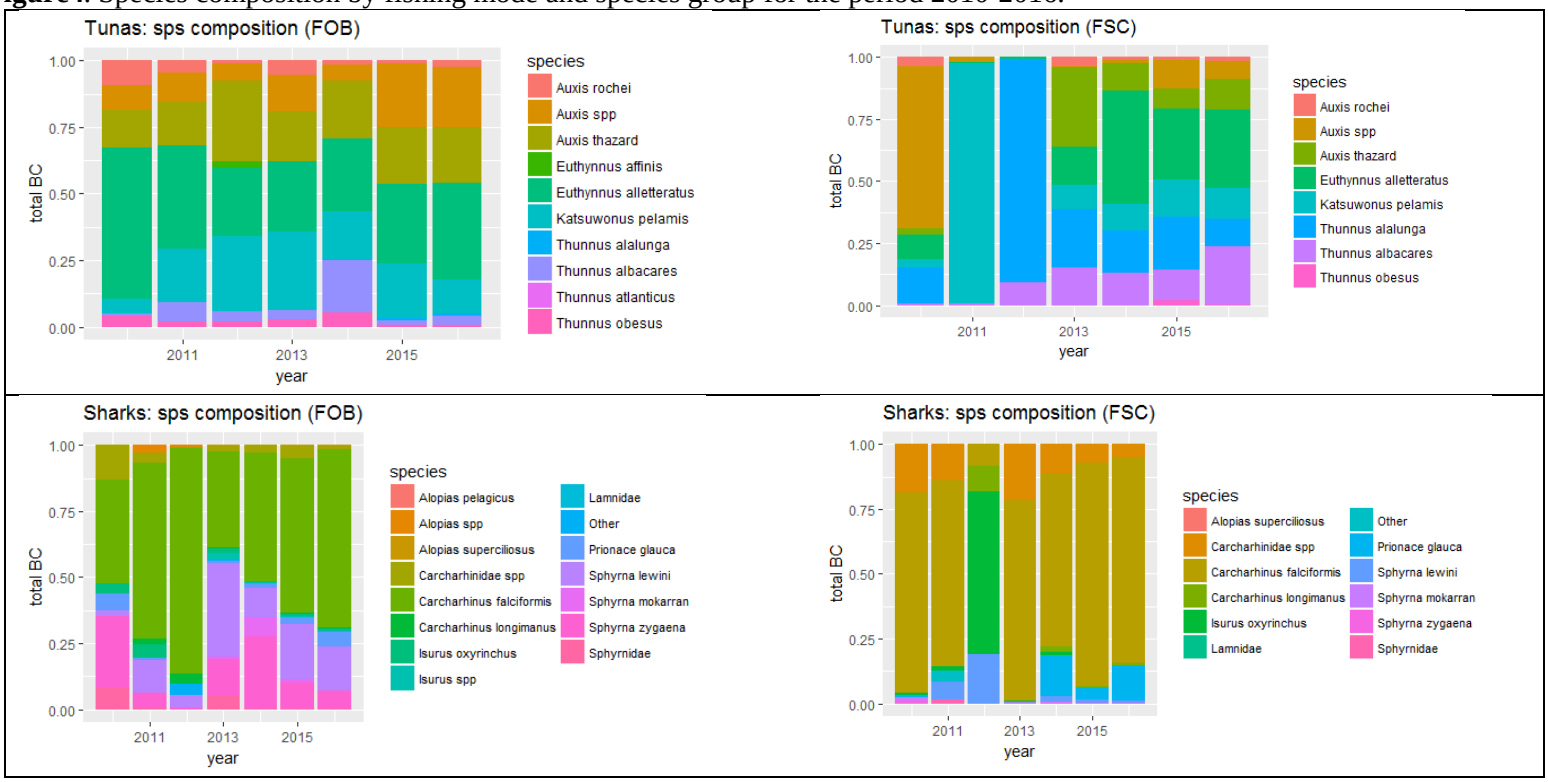
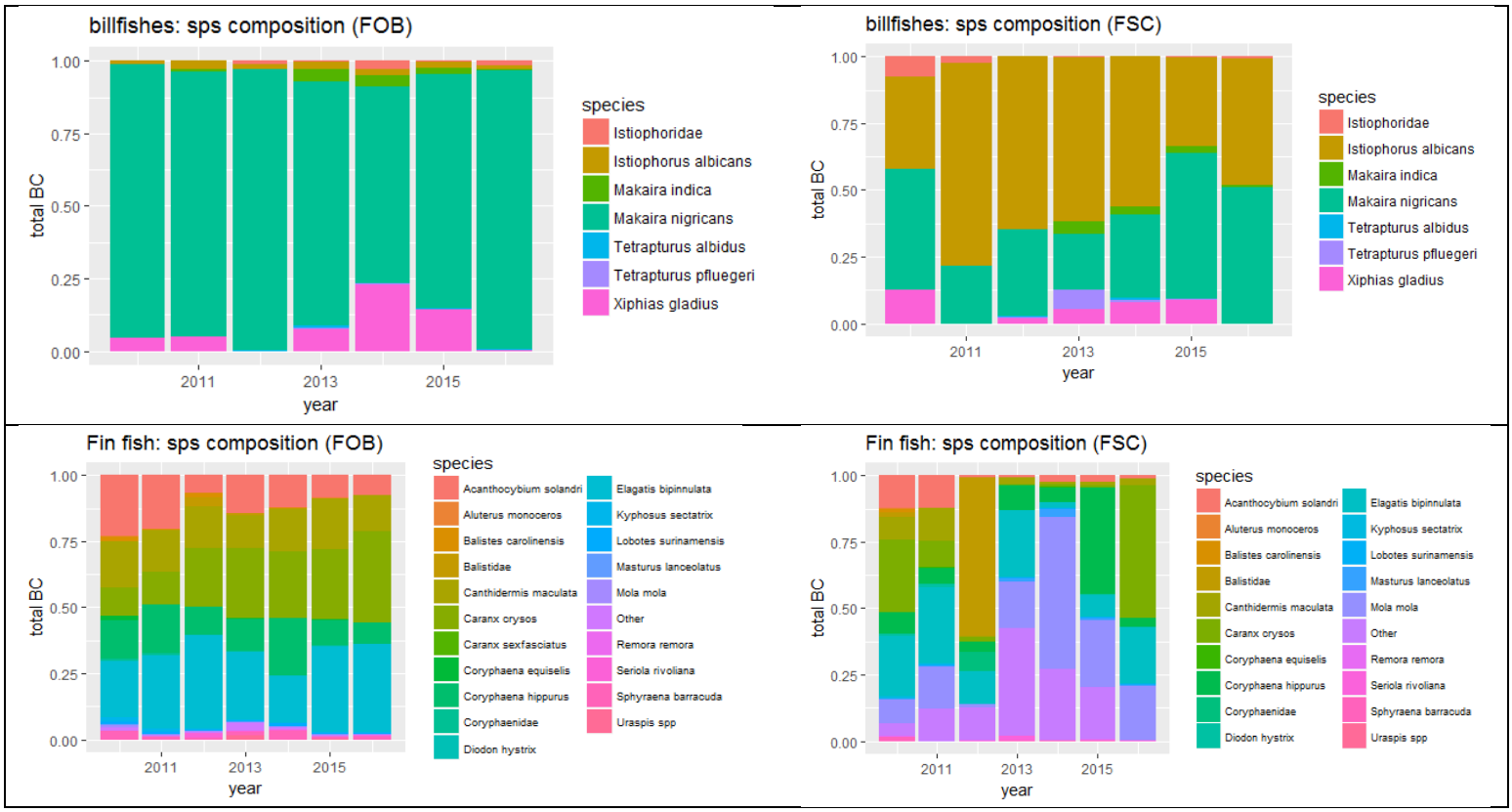


Figure4. Species composition by fishing mode and species group for the period 2010-2016.




billfishes: sps composition (FOB)
total BC
year
species
Istiophoridae
Istiophorus albicans
Makaira indica
Makaira nigricans
Tetrapturus albidus
Tetrapturus pfluegeri
Xiphias gladius
billfishes: sps composition (FSC)
Fin fish: sps composition (FOB)
Acanthocybium solandri
Aluterus monoceros
Balistes carolinensis
Balistidae
Canthidermis maculata
Caranx crysos
Caranx sexfasciatus
Coryphaena equiselis
Coryphaena hippurus
Coryphaenidae
Diodon hystrix
Elagatis bipinnulata
Kyphosus sectatrix
Lobotes surinamensis
Masturus lanceolatus
Mola mola
Other
Remora remora
Seriola rivoliana
Sphyraena barracuda
Uraspis spp
Fin fish: sps composition (FSC)